CLAIMS

What is claimed is:

1. An optical circulator comprising:

a first port;

a second port opposite to the first port;

a third port adjacent to the first port;

a first birefringent material optically coupled to the first port and the third port, the first birefringent material having a longitudinal axis, a transverse direction perpendicular to the longitudinal axis, a first displacement direction and a first length, the first displacement direction being at a first oblique angle from the transverse direction;

a first rotator pair, the first birefringent material being between first rotator pair and the first port;

a second birefringent material, the first rotator pair being between the first birefringent material and the second birefringent material, the second birefringent material having the longitudinal axis and a second displacement direction, the second displacement direction being perpendicular to the longitudinal axis,

a second rotator pair, the second birefringent material being between the first rotator pair and the second rotator pair; and

a third birefringent material, the third birefringent material having the longitudinal axis, the transverse direction perpendicular to the longitudinal axis, a third displacement direction and a second length, the third displacement direction being at a second oblique angle from the transverse direction;

wherein a first optical path is established from the first port to the second port, and a second optical path is established from the second port to the third port such that when an optical signal is input at the first port the optical signal travels along the first optical path to the second port and when the optical signal is input to the second port the optical signal travels along the second optical path to the third port.

2. The optical circulator of claim 1 further comprising:

a polarization beam deflector for altering a direction of the first optical path and the second optical path, the polarization beam deflector being located between the first rotator pair and the second birefringent material.

3. The optical circulator of claim 1 wherein the first rotator pair includes a first rotator and a second rotator, the first rotator rotating a polarization of an optical signal in a first direction, the second rotator rotating the polarization of the optical signal in a second direction opposite to the first direction; and

wherein the second rotator pair includes a third rotator and a fourth rotator, the third rotator rotating the polarization of the optical signal in the second direction, the fourth rotator rotating the polarization of the optical signal in the first direction.

4. The optical circulator of claim 1 wherein the first rotator further includes a first latching type garnet component, the second rotator includes a second latching type garnet component, the third rotator further includes a third latching type garnet component and the fourth rotator includes a fourth latching type garnet component, the first latching

type garnet component rotating the polarization of the optical signal by 45° in the first direction, the second latching type garnet component rotating the polarization of the optical signal by 45° in the second direction, the third latching type garnet component rotating the polarization of the optical signal by 45° in the second direction, the fourth latching type garnet component rotating the polarization of the optical signal by 45° in the first direction.

5. The optical circulator of claim 1 wherein the first and second oblique angles are each 45° from the transverse direction.

6. The optical circulator of claim 1 wherein the first length of the first birefringent material is sufficient to ensure that the first optical path is separated from the second optical path at the first birefringent material.

7. The optical circulator of claim 1 wherein the second length of the third birefringent material is sufficient to ensure that the first optical path is separated from the second optical path at the third birefringent material.

8. The optical circulator of claim 1 wherein the optical signal is capable of being decomposed into a first portion having a first polarization and a second portion having a second polarization and wherein the second birefringent material allows the first polarization state to be transmitted undeflected and the second polarization state to be transmitted with after being walked off by a first distance.

9. The optical circulator of claim 1 wherein the first port further includes a first fiber, the second port includes a second fiber, and the third port includes a third fiber.

10. The optical circulator of claim 1 further comprising a first collimator coupled to the first port and the third port, the first collimator including a C-lens or a GRIN lens.

11. The optical circulator of claim 10 further comprising a second collimator coupled to the second port, the second collimator including a C-lens or a GRIN lens.

12. An optical circulator comprising:

a first port;

a second port opposite to the first port;

a third port adjacent to the first port;

means for establishing a first optical path and a second optical path, the first optical path from the first port to the second port, the second optical path from the second port to the third port such that when an optical signal is input at the first port the optical signal travels along the first optical path to the second port and when the optical signal is input to the second port the optical signal travels along the second optical path to the third port, the optical path establishing means including

a first birefringent material optically coupled to the first port and the third port, the first birefringent material having a longitudinal axis, a transverse direction perpendicular to the longitudinal axis, a first displacement direction and a first length, the first displacement direction being at a first oblique angle from the transverse direction;

a second birefringent material, the first birefringent material being between the first port and the second birefringent material, the second birefringent material having the longitudinal axis and a second displacement direction, the second displacement direction being perpendicular to the longitudinal axis,

a third birefringent material, the second birefringent material being between the first birefringent material and the third birefringent material, the third birefringent material having the longitudinal axis, the transverse direction perpendicular to the longitudinal axis, a third displacement direction and a second length, the third displacement direction being at a second oblique angle from the transverse direction.

13. A method utilizing an optical circulator, the optical circulator including a first port, a second port and a third port adjacent to the first port, the method comprising the steps of:

(a) inputting the optical signal to a first port or a second port opposite to the first port;

(b) transmitting the optical signal through a means for establishing a first optical path and a second optical path such that when an optical signal is input at the first port the optical signal travels along the first optical path to the second port and when the optical signal is input to the second port the optical signal travels along the second optical path to the third port, the first optical path from the first port to the second port, the second optical path from the second port to the third port, the optical path establishing means including a first birefringent material optically coupled to the first port and the third port, the first birefringent material having a longitudinal axis, a transverse direction perpendicular to the

longitudinal axis, a first displacement direction and a first length, the first displacement direction being at a first oblique angle from the transverse direction, a first rotator pair, the first birefringent material being between first rotator pair and the first port, the first rotator pair includes a first rotator and a second rotator, the first rotator rotating a polarization of an optical signal in a first direction, the second rotator rotating the polarization of the optical signal in a second direction opposite to the first direction, a second birefringent material, the first rotator pair being between the first birefringent material and the second birefringent material, the second birefringent material having the longitudinal axis and a second displacement direction, the second displacement direction being perpendicular to the longitudinal axis, a second rotator pair, the second birefringent material being between the first rotator pair and the second rotator pair, the second rotator pair including a third rotator and a fourth rotator, the third rotator rotating the polarization of the optical signal in the second direction, the fourth rotator rotating the polarization of the optical signal in the first direction, and a third birefringent material, the third birefringent material having the longitudinal axis, the transverse direction perpendicular to the longitudinal axis, a third displacement direction and a second length, the third displacement direction being at a second oblique angle from the transverse direction.

14. The method circulator of claim 13 wherein the transmitting step (b) further includes the step of:

(b1) transmitting the optical signal through a polarization beam deflector for altering a direction of the first optical path and the second optical path, the polarization beam deflector being located between the first rotator pair and the second birefringent material;

15. The method of claim 14 wherein the first rotator further includes a first latching type garnet component, the second rotator includes a second latching type garnet component, the third rotator further includes a third latching type garnet component and the fourth rotator includes a fourth latching type garnet component, the first latching type garnet component rotating the polarization of the optical signal by 45° in the first direction, the second latching type garnet component rotating the polarization of the optical signal by 45° in the second direction, the third latching type garnet component rotating the polarization of the optical signal by 45° in the second direction, the fourth latching type garnet component rotating the polarization of the optical signal by 45° in the first direction.

16. The method of claim 13 wherein the first and second oblique angles are each 45° from the transverse direction.

17. The method of claim 13 wherein the first length of the first birefringent material is sufficient to ensure that the first optical path is separated from the second optical path at the first birefringent material.

18. The method of claim 13 wherein the second length of the third birefringent material is sufficient to ensure that the first optical path is separated from the second optical path at the third birefringent material.

19. The method of claim 13 wherein the optical signal is capable of being decomposed into a first portion having a first polarization and a second portion having a

second polarization and wherein the second birefringent material allows the first polarization state to be transmitted undeflected and the second polarization state to be transmitted with after being walked off by a first distance.

20. The method of claim 13 wherein the first port further includes a first fiber, the second port includes a second fiber, and the third port includes a third fiber.

21. The method of claim 13 further comprising a first collimator coupled to the first port and the third port, the first collimator including a C-lens or a GRIN lens.

22. The method of claim 13 further comprising a second collimator coupled to the second port, the second collimator including a C-lens or a GRIN lens.